

OBITUARY NOTICES OF FELLOWS DECEASED.

WILLIAM JOHN MACQUORN RANKINE was born at Edinburgh on the 5th July, 1820. He was the son of David Rankine (a lieutenant in the Rifle Brigade, and a younger son of Macquorn Rankine, of Drumdow, of a well-known family in the county of Ayr), and of Barbara Grahame, one of the daughters of Archibald Grahame, of Dalmarnock, a banker in Glasgow. He was educated partly at Ayr Academy, partly at the High School of Glasgow, from which he went to the University of Edinburgh; but he derived much of his instruction from his father, and, like most men who have made any real mark in science, he owed the greater part of his knowledge to his own energy and industry. In 1836 he received a gold medal for an essay on the Undulatory Theory of Light, and in 1838 he gained an extra prize for his essay on Methods of Physical Investigation. Shortly after this date he entered upon the profession of Civil Engineering, as a pupil of Sir John McNeill, under whose direction he was employed from 1839 to 1841 in various schemes for waterworks and harbour-works in the north of Ireland, and on the Dublin and Drogheda Railway. At this time he invented a method of setting out curves which still bears his name. From 1844 to 1848 he was employed, under Locke and Errington, on the construction of the Clydesdale Junction Railway, and subsequently upon various schemes promoted by the Caledonian Railway. In 1845-46 he was engineer of the proposed Edinburgh and Leith waterworks, a scheme which was defeated by the rival Edinburgh Water Company. In 1852, he and the late John Thompson were joint engineers of the well-known works by which Glasgow is supplied with pure water from Loch Katrine. In November of 1855 he was appointed Regius Professor of Civil Engineering and Mechanics in the University of Glasgow: he retained this chair until his death, which occurred on the 24th December, 1872.

It is difficult to determine whether Rankine takes his highest place as an original investigator, or in respect of his great success in digesting the scientific knowledge of himself and his contemporaries into a form available for common use. His works have the very rare merit of being *thorough*, both in a scientific and in a practical sense. With great originality of treatment, and frequently of research, his text-books exhaust the useful theory of his subjects, and his results are always reduced to a form in which they can be actually used. His practice as an engineer had made him fully alive to the important difference between the crude results of theoretical reasoning from principles and the reduced formulæ adapted to the data obtainable from observation or specification. There is probably no scientific writer to be compared with him in the three aspects of the extent covered by his treatises—their scientific accuracy and exhaustiveness and their immediate adaptation to the use of practical men, who may be utterly unable to follow the reasoning by which he arrived at his formulæ. There are persons who think that the path-finder in science is of a higher and rarer order of

intelligence than the road-maker. There are those who think otherwise; who consider that the latter frequently displays the broader and more masculine intellect. However this may be, all rational men agree in awarding the highest meed of praise to those who can both find the path and make the road,—who can say to the little children of science, so far can you follow me—and to the maturer minds, from that point you may extend my paths. Of these men was Rankine.

Rankine's most important contributions to science are in the dynamical theory of heat, in the theory of the steam-engine, in that of waves in liquids, especially of sea-waves, and on the resistance and rolling of ships. He was among the earliest students in this country who were able to understand what was meant by thermodynamics. He contributed largely to the extension and settlement of the theory, and, probably to a greater extent than any other person, to its reduction to rules adapted to the practice of engineers; indeed he may be considered one of the founders of the science. In the study of waves in liquids, he and Mr. William Froude appear to have been the first persons who successfully worked out a possible theory of waves of finite displacement in the sea: all the previous researches were either incomplete in theory or limited to infinitesimal disturbance. Rankine and Froude, working independently of one another, appear to have been the first to arrive at a definite demonstration of the mechanical possibility of the trochoidal wave. They were not the first to suggest that the trochoid was the clue to the geometry of the sea-wave: Gerstner and Scott Russell had already done that; but it was Froude, in the 'Transactions of the Institution of Naval Architects,' and Rankine, in the 'Transactions of the Royal Society,' who first gave proof that it complied with all the conditions of fluid motion, except that of the absence of molecular rotation.

His study of the resistance of ships appears to have been suggested to him by an application addressed to him and to Professor (now Sir William) Thomson by his friend James Robert Napier, for advice as to the power necessary to propel vessels of any form. Professor Thomson then called attention to the defect in existing theories, with reference to the resistance of water to a ship's progress, from not taking account of the viscosity of the fluid. Professor Rankine stated that if the resistance outside a ship was the same as that inside a water-pipe, the power required to propel a certain vessel would be so and so, naming a power of about two thirds what Mr. Napier had estimated to be necessary. Alluding to this, Professor Rankine wrote, in August 1858, to the *Philosophical Magazine* (ser. 4, vol. xvi. p. 238):—"In the course of last year there were communicated to me *in confidence* the results of a great body of experiments on the engine-power required to propel steamships of various sizes and figures at various speeds. From those results I deduced a general formula for the resistance of ships having such figures as usually occur in steamers, which, on the 23rd of December,

1857, I communicated to the owner of the experimental data; and he has since applied it to practice with complete success." This circumstance no doubt led to his addressing himself to the theory of ships. With this object in view, he investigated the form and mechanical work both of sea-waves and of waves in canals, the waves which accompany ships, the loss of work consequent on the formation of divergent waves, the stream-lines or lines of motion of water flowing past a ship, the effect of the combined oscillation of a ship and a wave, the steadying effect of keel-resistance, and many other important points of the hydraulics of a ship. On nearly all these points he did important original work, although in many of them the credit must be shared between him and others who were working abreast of him—notably Sir W. Thomson and Mr. W. Froude. He also studied the question of propulsion, and placed its theory on a sound basis. This branch of knowledge owes more to Rankine than to any other writer.

His principal published works are his 'Manual of Applied Mechanics,' a volume of about 640 pages, published in 1858; his 'Manual of the Steam-Engine and other Prime Movers,' a volume of 580 pages, published in 1859; his 'Manual of Civil Engineering,' a volume of 780 pages, published in 1862; his 'Manual of Machinery and Millwork,' a volume of 580 pages, published in 1869; and his book of 'Useful Rules and Tables,' published in 1866. Besides these, he was the corresponding editor of, and principal contributor to, the great work of 'Ship-building, Theoretical and Practical,' by Watts, Napier, Barnes, and Rankine, published in 1864-66. All these treatises have the great merits of being exhaustive, dropping out or avoiding no part of their subject, of bringing down their scientific information close upon the very date of their publication, and of having all their results reduced to a workable form. When it is added that they are terse and concise almost to a fault, and that they cover the whole of the ground from simple addition to the application of elliptic functions in pure mathematics, and from the common lever to the ellipsoids of stress and of rotation, and to the friction of gases, in applied mathematics, some idea may perhaps be formed of the immense mass of knowledge which Rankine succeeded not only in acquiring, but in reducing to a shape available in the every-day work of practical men.

As an instance of the wide generality of his interest in scientific research, may be mentioned his papers in the 'Engineer' of 1869, in which he explained the curious dynamical theory of the bicycle, or two-wheeled velocipede, which had just then come into general use. These papers are still the most complete treatise on the subject.

The joint report of Professor Rankine and Dr. Stevenson Macadam on the accident which took place in 1872 at the Tradeston Flour-Mills, by the explosive firing of air charged with flour-dust, is also a most remarkable proof of his power to handle work of a miscellaneous character.

In the 'Catalogue of Scientific Papers,' compiled under the care of the

Royal Society, Rankine is credited with eighty papers down to the year 1865. He has published a very considerable number since that date. His last, and one of his most important contributions to the Philosophical Transactions is that "On the Mathematical Theory of Stream-lines," read before the Royal Society on the 10th February, 1870. This paper contains a remarkably complete investigation of the lines of motion of particles of liquid in flowing past certain solid bodies, such as ships, and of the mechanical as well as the geometrical character of the disturbance.

It is satisfactory to reflect that his labours met with full recognition during his lifetime from the scientific bodies best qualified to judge of their merits. In 1849 he was elected a Fellow of the Royal Society of Edinburgh. In 1850 he acted as Secretary to Section A of the British Association, which then met at Edinburgh. In 1845 he was elected a Member of the Philosophical Society of Glasgow, and in 1853 a Fellow of the Royal Society of London. In 1854 he was awarded the Keith Medal of the Royal Society of Edinburgh for researches in Thermodynamics. In 1855 he was appointed one of the Visitors of Edinburgh Observatory, and in the same year Regius Professor of Civil Engineering and Mechanics in the University of Glasgow. He was also President of Section G of the British Association when it met in Glasgow in 1855. In 1856 he received the honorary degree of LL.D. of Trinity College, Dublin. In 1863 he was awarded the gold medal of the Institution of Engineers in Scotland for a paper "On the Liquefaction of Steam;" and in the same year he was President of Section A of the British Association at Newcastle-on-Tyne. In 1867 he was again President of Section G at Dundee. In December 1870 he was appointed a member of the Admiralty Committee on Ships of War, which arose out of the loss of H.M.S. 'Captain,' and he contributed largely to the scientific part of the report.

His great industry and success in the field of science were never allowed to interfere with the ordinary duties owing to society, or with those sacrifices of time which all men are called upon to make for the gratification of others. Thoroughly genial in company, affectionate and beloved in his family circle, careful and yet liberal in the relations of business, amiable and even in temper, it was as great a pleasure as it was an honour to be counted among his friends. He has not unfrequently sung a song of his own writing to music of his own composing; and, what is more, the voice, the music, and the words were all worth listening to.

His illness began by a failing of the eyesight, which was at first supposed to be local, but which afterwards proved to be but a symptom of more deeply seated disease. Under treatment, he recovered from a severe attack of illness in October 1872, and up to within five days of his death no unfavourable symptoms occurred: then a change took place; he rapidly lost the power of speech, and the sensibility of the right side. He died on the 24th December, 1872.

He was never married. His only brother died while he was yet young, and he lost his father and his mother a year or two before his own death.

JOHN BISHOP was born on the 15th September, 1797, and died on the 29th September, 1873. He was the fourth son of Samuel Bishop, Esq., of Pimperne, in the county of Dorset, and received his education at the Grammar School of Mr. Longman at Childe Okeford in the same county, where he remained several years. He was originally intended for the legal profession; but negotiations for this object having been broken off through some misunderstanding between the contracting parties, he pursued for some time the idle but agreeable life of a country gentleman, and his favourite field sports, hunting and shooting. When about five and twenty years of age, he was induced by his cousin, Mr. John Tucker, a surgeon of Bridport, to enter the medical profession; after a short preliminary study and practice at Bridport, he came to London, where he entered at St. George's Hospital under Sir Everard Home. During his student days he attended the lectures of Sir Charles Bell, then in his zenith, of Mr. Guthrie, Dr. George Pearson, and the Chemical Courses at the Royal Institution. In 1824 he obtained the diploma of the Royal College of Surgeons, and in 1851 was elected a Member of the Council of the College, where he retained a seat for nearly twelve years. In 1844, having previously published a paper in the *Philosophical Transactions* on the Physiology of the Human Voice, he was elected a Fellow of the Royal Society, and a Corresponding Member of the Medical Societies of Berlin and Madrid. About this time he also obtained from the Royal Academy of Sciences, Paris, two prizes for memoirs on the Human and Comparative Anatomy and Physiology of Voice. He contributed to Todd's '*Cyclopædia*' the articles "*Larynx*," "*Motion*," and "*Voice*," and was the author of works on Distortions of the Human Body, on Impediments of Speech, and on Hearing and Speaking Instruments. These works, together with several minor contributions to medical literature, gained for Mr. Bishop the well-deserved reputation of a careful and skilful observer, and are remarkable for the evident pains taken by the author to examine and do justice to whatever had been written by others upon the subject he had under consideration, and, where practicable, to prove by mathematical demonstration every theory he himself advanced.

During his career Mr. Bishop held the offices of Senior Surgeon to the Islington Dispensary, Surgeon to the Northern Dispensary, to the St. Pancras Dispensary, and to the Drapers' Benevolent Institution. In 1852 he was elected President of the Medical Society of London, and held the offices of Trustee, Councillor, Orator, and Lettsomian Lecturer to the Society. He was also for many years, and at the time of his death, one of the managers of the Russell Institution. He was a man of considerable energy of character; and although undemonstrative in his manner, entered zealously into any business he undertook, and exercised great personal influence upon his colleagues. His judgments, deliberately formed and carefully expressed, carried considerable weight with them, and influenced

the decision of many a council meeting. He had the tact of opposing without irritating; and even those to whom on questions of public business he might find himself opposed, were ever ready to do justice to the honesty of purpose and singleness of aim by which he was actuated. Of many and varied attainments, an enthusiastic admirer of music and of art, conversant with continental as with English literature, he continued until within a few months of his death to take an active interest in all the discoveries and achievements of modern science. The philosophical bias given to his mind by the eloquent teachings of Sir Charles Bell remained with him to the last, and was manifested both in his writings and in his conversation.

Full of years, tended by those he loved, conscious of having gained and maintained to the last an honourable if not distinguished reputation, at Strangeways-Marshall, Dorset, within a few miles of his birthplace, this estimable life drew to a close. It is no exaggeration to say that by all who were acquainted with him Mr. Bishop was respected and esteemed; but only those who knew him intimately can bear full testimony to the kindly feeling and genial worth that preeminently characterized the subject of this imperfect memoir.

BALDWIN FRANCIS DUPPA was the eldest son of Baldwin Francis Duppa, B.A. (Oxon.), and Barrister-at-law. His parents spent the first few years of their married life abroad; and their eldest son and first child was born, February 18, 1828, at Rouen in Normandy. His early taste for experimental investigation involved young Duppa in a most disastrous accident; for when he was only seven years old he poured the contents of a powder-flask into the fire, causing an explosion which shattered his hand, blinded him for some time, and deprived him of the use of a thumb for life.

He received his early education at the celebrated school of M. de Fellenberg at Hofwyl near Berne, where he was the intimate companion of Henri the grandson of De Saussure. Here he acquired a good knowledge of French, German, and Swiss-German, and spoke the first two languages at that time so well that in returning from Switzerland he was twice taken for a runaway from school (once for a French boy and once for a German), and had some trouble to persuade the diligence officials to let him pass. To these languages he subsequently added Italian and Arabic. It was one of the features at Hofwyl that each boy should learn some useful trade during play hours; and young Duppa took up carpentering, becoming very expert in the making of ornamental boxes and other small articles. To this early development of mechanical skill was doubtless due some of that extraordinary manipulative power and fertility of invention which afterwards characterized his laboratory work. Quickly seizing upon the essential conditions for the performance of a given chemical operation, the prompt construction of the necessary apparatus,

out of any materials which happened to be at hand, seemed to cost him no trouble: glass, wood, and metal were all alike made to obey his hand; and the suggestion of an experiment, chemical or physical, had not usually to wait many hours for its realization.

Duppa retained to the last a great affection for this school, often speaking of the happiness of the life he led there and of the excellency of the training, in the highest terms, and contrasting it with an English school to which he was afterwards sent, where he was very unhappy and learnt nothing. At Hofwyl there were no rewards and no punishments strictly so called, and the pupils were encouraged to cultivate habits of observation.

When only twelve years old he lost his father, who died at the early age of thirty-seven. He was now removed from the Swiss school after spending only three years there; nevertheless he always contended that he received his education at Hofwyl. After leaving the English school he had some private tuition, and then proceeded to Cambridge, where he made the acquaintance of Prof. W. Hallowes Miller, for whom he ever afterwards retained a warm regard. He left Cambridge without taking a degree, and began to read for the bar; but finding the sedentary work utterly repugnant to his tastes, he abandoned it and went to Italy for three years to recruit his health, which was, even at this time, by no means strong. Here he turned to account the knowledge of mineralogy which he had acquired at Cambridge, and made a small collection of rare and interesting minerals. Returning from Italy in the year 1854, he determined to devote himself to the study of Chemistry. With this view he entered the Royal College of Chemistry as a pupil of Dr. Hofmann in the autumn of 1855. We find him in 1857 engaged upon his first original investigation on the action of sulphuric acid upon salicylic acid, by which he obtained sulphosalicylic acid*. He afterwards prepared and investigated bromide of titanium. On leaving the College of Chemistry he fitted up a laboratory in his country seat at Hollingbourne near Maidstone, where, in conjunction with Mr. W. H. Perkin, he commenced a series of most interesting and important investigations on the substitution products of acetic, malic, and succinic acids, which culminated in one of the greatest achievements of synthetical chemistry—the artificial production of tartaric acid. These researches are described in seven memoirs published in the *Philosophical Magazine* and the *Journal of the Chemical Society*†.

Finding his residence at Hollingbourne severed him almost entirely from scientific associates, he abandoned his private laboratory, came in 1860 to reside in London, and worked for some months in the laboratory of Dr. Frankland at St. Bartholomew's Hospital. Here he

* Jahresbericht der Chemie, 1857, p. 322.

† *Phil. Mag.* (4) xiv. 217; *Quarterly Journal of Chem. Soc.* xi. 22; *Phil. Mag.* (4) xvii. 280; *Phil. Mag.* (4) xviii. 54; *Quarterly Journ. of Chem. Soc.* xiii. 1, 2, and 102.

devoted himself in the first instance to a study of the modern delicate methods of gas-analysis. Over these his great manipulative skill soon gave him the complete mastery. At that time Frankland was engaged in the investigation of the action of zincethyl upon boric ethylate; and in this research Duppá eagerly joined. The first results were recorded in a joint paper communicated to the Royal Society in July 1860*. In this paper, the discovery of boric ethide, boric etho-diethylate, and boric etho-dihydrate was announced, and the chief properties of these bodies described. The materials for this paper had scarcely been obtained, when Duppá's health became so seriously impaired that he was obliged to leave England and spend a couple of years in Italy and Algeria, whence he returned in 1863 and rejoined Frankland, who had, in the mean time, been translated to the laboratory of the Royal Institution. Here, in the quiet of a gloomy room in the basement, the two chemists, free from the wearing duties of teaching the elements of the science, devoted themselves heart and soul to original research; the inventive and constructive skill of Duppá, aided by the liberality of the Managers of the Institution, soon transformed this gloomy cell into a laboratory which might be fairly regarded as a model of convenience for the class of work carried on in it. At first the neighbours were loud in their complaints of bad odours; but it was discovered that these could be obviated by securely closing the windows of the laboratory, which was done. The atmosphere inside was thus rendered anything but agreeable; it was, indeed, sometimes so highly charged with vapours as almost to prevent the eye from penetrating from one side of the room to the other: but this was not found to be an unmitigated evil; it effectually prevented those interruptions to work which are so common in London; for no non-worker could bear in the room more than a few minutes, and rarely visited it a second time. One visitor nearly fainted, and had to be quickly removed to fresh air to revive him. Thanks to the Royal Institution Research Fund, and to the Government Grant administered by the Royal Society, the means for the purchase of apparatus and chemicals were never wanting.

From this laboratory there issued in three years no less than fourteen papers, of which Duppá was the joint author, descriptive of original researches, and published in the *Philosophical Transactions*, the *Proceedings of the Royal Society*, and the *Chemical Society's Journal*.

These researches related, first, to the synthetical genesis of acids of the lactic, acetic, and acrylic series; secondly, to the production of compounds of mercury with the organic radicals methyl, ethyl, and amyl; thirdly, to the synthetical formation of ketones; and fourthly, to the transformation of organo-mercury compounds into organo-zinc compounds. The records of these researches constitute the best testimony

* *Proc. Roy. Soc.* vol. x. p. 568.

to the enthusiastic zeal with which Mr. Duppá prosecuted chemical investigation during these years.

In 1867 Dr. Frankland resigned his professorship at the Royal Institution; and Mr. Duppá accompanied him to the private laboratory at the Government College of Chemistry, which was then in its old quarters in Oxford Street; but the meagre resources of this laboratory could not, even in his hands, be turned to account for the prosecution of these investigations, and the work had to be abandoned in despair; or rather it was postponed in anticipation of the completion of the new laboratories at South Kensington, which had been promised from year to year. At length, early in the present year, the new research laboratory was partially completed, and Duppá, all eagerness to recommence the work so long in abeyance, took a house in London, solely to enable him to prosecute his chemical labours. Alas! it was too late. Before he could again resume that which always afforded him so much pure pleasure, he was attacked by the malady which prematurely cut short his useful life. He died of consumption at Budleigh-Salterton, Devonshire, on the 10th of November, aged forty-five years, retaining his interest in experimental science to the last. A few hours before his death he dictated a long letter, accompanied by a diagram, to Professor Tyndall on a curious optical phenomenon which he had recently observed.

Mr. Duppá was elected a Fellow of the Royal Society in 1867. He married in 1869 Adeline Frances Mary Dart, the only surviving child of J. H. Dart, Esq., Barrister-at-Law, of Beech House near Ringwood, Hants. He leaves a widow and one child. He was a warm-hearted and faithful friend, and, as a landowner and Justice of the Peace in Kent, he was well known and much esteemed. His devotion to science did not prevent his taking a deep interest in art. He was a painter of no inconsiderable ability; and from his frequent wanderings in search of health in France, Spain, Switzerland, Italy, Algeria, and Madeira he always brought home his portfolio well filled with beautiful and interesting sketches, in which he sometimes embodied the effects of ancient and modern volcanic and glacial action with great vividness and truth.

Having a small private fortune, he never applied for nor held any scientific appointment. He always entertained a disinclination to lecturing and public speaking. Had this been otherwise, he could scarcely have failed to make his mark as a lecturer on his favourite science; for in conversation he had few rivals in popular scientific exposition, and in the laboratory perhaps none in devising appropriate experimental illustrations of chemical phenomena. He was one of that small band of enthusiastic and disinterested amateur labourers who have performed so large a proportion of the original scientific work of this country, and of whom England may justly feel proud.